ENERGY USE ENGINEERING DEPARTMENT

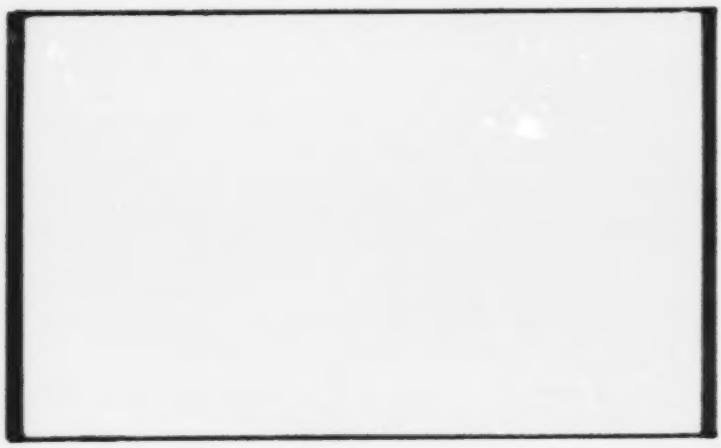
PROJECT 8130

IMPACT OF POTENTIAL NEW APPLICATIONS ON ELECTRIC SERVICE NEEDS

1980 - 2005

ENERGY CONSERVATION DIVISION

B.C. HYDRO AND POWER AUTHORITY



ENERGY USE SERVICES

The Energy Use Engineering Department provides engineering, technical and marketing impact advice on energy use with emphasis on energy management, prudent energy usage, efficient applications and energy conservation.

The service is provided by a team of four sections supervised as follows:

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ENERGY USE ENGINEERING DEPARTMENT
ENERGY CONSERVATION DIVISION
B.C. HYDRO AND POWER AUTHORITY

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PROJECT 8130

IMPACT OF POTENTIAL NEW APPLICATIONS ON ELECTRIC SERVICE NEEDS 1980 - 2005

SYNOPSIS:

Potential new applications generated by existing and ensuing technologies could add 2,218 MW of new load by 2005. This would represent a significant addition to the current forecasts and is in the order of 20%.

PROJECT:

Initiated by:	R. W. Racine
Date Completed:	25 March 1983
Completed by:	W. P. Jenkins, with the assistance of the EUE Dept.
Supervised by:	R. F. Hughes
Approved by:	R. W. Racine, Manager Energy Use Engineering
Initial Distribution:	T. J. Newton EUE Department Supervisors

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ENERGY USE ENGINEERING DEPARTMENT

PROJECT SUMMARY

PROJECT No. 8130 PRIORITY 2

TITLE: IMPACTS
OF POTENTIAL "NEW" APPLICATIONS
ON ELECTRIC SERVICE NEEDS
B.C. HYDRO SYSTEM 1980 - 2005

INITIATED/REQUESTED BY: R.W. Racine

ASSIGNED TO: R.F. Hughes ASSIGNED BY: R.W. Racine

DATE ASSIGNED: 81/10/14 DATE REQUIRED: ASAP

ESTIMATED COMPLETION: 1982 COMPLETED: 25 March 1983

OBJECTIVES AND NOTES:

The impacts of potential "new" applications can increase electric service needs on the B.C. Hydro electric system.

"New" applications for this analysis are defined as new foreseeable applications which for various reasons are not presently widely used on our system. Examples include electric vehicles, convenience appliances, heat pumps, equipment for environmental control, automated electrified processes and recreational facilities.

The objective of this project is to:

- harness the expertise available in the EUE Dept. and elsewhere as appropriate to develop the potential impacts of each foreseeable meaningful application on the BCH electric system in the 1980 - 2005 period
- for coordination, develop per account impacts related to the 1980 base year per account usage similar to that developed for the energy conservation impact analyses and outlined in Appendix 1 of 8130.
- before the end of 1982, provide a report on the information available and provide data which identifies the relative potential increases with various applications and the totals
- periodically update 8130 where appropriate

(Reference EUE Energy Usage file)

COPIES TO: DEPARTMENT MANAGER (THEN RECORD FILE), BLUE FILE, SUPERVISOR,
EUE Supervisors
T.J. Newton
R. Schneider

PLEASE ADVISE AS SOON AS POSSIBLE IF CHANGES ARE REQUIRED ABOVE

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1.0 EXECUTIVE SUMMARY

As the nature of technology changes, the greatest change befalling people will be one of re-defining their roles in society. Concommittant with the acceptance of the need for change is the ability to power that change - the responsibiilty of B. C. Hydro. Inevitably, the future impact of advancing technological change will require it to be considered a viable addition to Hydro's load patterns.

This report attempts to address the major areas of anticipated future new load - it is not a definitive interpretation since realistically each section should form the basis of an indepth separate report. Due to time and logistic constraints, it has been impossible to analyze every potential impact area but the report does serve as a preliminary step in defining the relevant parameters.

Table 1 summarizes the projected impact of new technology on B. C. Hydro's service needs, through to 2005 by various demand areas. Approximately 2,220 MW of new demand due to new applications may impact B. C. Hydro's service needs at that time.

Potential New Load	1985	1990	1995	2000	2005
Rail Electrification	205	325	400	450	453
Electric Vehicles and Residential Applications	179	292	444	604	775
Electronic Developments	233	285	344	404	458
Environmental Control	197	247	309	669	433
HVAC and COSP	21	40	60	76	99
Large Industrial Processes	Nil	Nil	Nil	Nil	Nil
Innovative Industrial Loads	Unknown	Unknown	Unknown	Unknown	Unknown
Recreational Facility Usage	Nil	Nil	Nil	Nil	Nil
Totals (MW)	835	1189	1557	2203	2218
B. C. Hydro 1981 Load Forecast (MW)	6,760	7,530	8,730*	10,121*	11,734*
New Load as Percentage of Total	12.4%	15.8%	17.8%	21.7%	18.9%

* Based on a low projection of 3.0% load growth per annum.

Table 1: Summary of Impact of New Technology on B. C. Hydro's Service Needs (MW)

The above figures indicate that new technology will have a significant impact as projected load growth.

2.0 INTRODUCTION

Rapid advances in all facets of electrotechnology have impacted the whole electrical spectrum. This accelerative thrust translates, from the utility standpoint, into new and future load. This report then focuses on key electrical usage areas and objectivizes the potential impact of new applications on B. C.'s electrical service needs to the year 2005.

This study attempts to address NEW applications and does not violate previous impact studies which cover conservation practices. The report is unique in that it tries to identify energy usage which has not otherwise been taken account of.

Increased demand will be facilitated by the advent of:

(a) new technology;
(b) reduced labour participation;
(c) conventional energy service price increases;
(d) foreign oil avoidance;
(e) changing lifestyles.

All will contribute in varying amounts to greater electrical energy requirements during the forthcoming 20 years.

The demand for electricity is expected to continue, but at a lower rate than originally predicted. Original electric demand was forecast (May 1982) to rise 4.7% per annum up until 1993, but was revised downwards to 4.3%. This 4.3% includes load growth forecasts for the West Kootenay Power and Light Co., which has presently reached the limit of its own generating capacity. Without the WKP&L load, the annual forecast growth rate for all electric power production would be reduced to 3.9%.

The major areas delineated and examined hereinafter range from seemingly minute electronic loads through to potentially major industrial installations. The actual areas identified being:

(a) rail electrification;
(b) electric vehicles;
(c) electronic developments (office environment);
(d) environmental control/waste management;
(e) Canadian Oil Substitution Program (COSP) and low energy residences;
(f) large industrial processes including robotics;
(g) recreational facility usage;
(h) miscellaneous process/industrial loads.

The responsibility for researching and analyzing each area was accomplished by the Applications, Residential, Electrical and Lighting and HVAC Sections of the Energy Use Engineering Department in B. C. Hydro. The above listed areas are discussed in the next part of the report and their projected net effects with respect to load impact data are tabulated in the Summary.

3.0 RAIL ELECTRIFICATION

The electrification of rail transport systems in B. C. has the potential of adding a very significant load to Hydro's network. The projected increases are tabulated in Table 2.

Line	Company	Miles	Consumption, MW.h/Year 1985	1990	1995	2000	2005
Tumbler Ridge to Anzac	BCR	80.0	35,261	35,261	35,261	35,261	35,261
Field to Golden	CPR	35.0	59,815	103,540	132,480	132,480	132,480
Golden to Vancouver	CPR	428.7	1,162,662	1,162,662	1,162,662	1,162,662	1,162,662
Crowsnest to Golden	CPR	238.0	291,383	520,423	813,351	813,351	813,351
Lucerne to Red Pass	CNR	22.1	24,455	34,395	48,376	68,039	68,039
Red Pass to Port Mann	CNR	467.1	281,428	502,630	897,769	1,311,565	1,311,565
Chilliwack to Vancouver	BCHR	194.4			possibilities		
Greater Vancouver	ALRT	60.0		2,610	5,220	6,900	8,700
Total GW.h			1,855	2,361	3,095	3,530	3,531
Electrified lines within B. C.		1545 mi (2456 km)					

Table 2: Electric Rail Potential in B. C. - 1985-2005
(Cited in B. C. Hydro EUE Project 8216)

At present (1983) work has commenced on two projects:

(a) The B. C. Railway 129 km Anzac to Tumbler Ridge branch line, built to transport metallurgical coal from B. C.'s northeast to Ridley Island terminal in Prince Rupert. Thereupon to be shipped for export. It is envisaged that the first trains will commence operation in 1984.

(b) The Greater Vancouver Automated Light Rapid Transit (ALRT) fast commuter train is presently under construction and scheduled for completion in 1986.

Whether the remaining projects listed in Figure 1 are implemented will depend upon provincial electrification policy. This will ultimately be influenced by:

(a) the success of the projects;
(b) the economics of rail electrification.

It is presently estimated that $1 billion of capital investment is required to realize these plans (not including Anzac-Tumbler Ridge and ALRT). A number of other factors are pertinent and will input the final decision, namely:

(a) new technological developments;
(b) marketing and promoting of rail electrification;
(c) political climate extant over the next 20 years.

The average projected additional load brought about by rail electrification for benchmark years is shown in Table 1. These figures are obtained by dividing the total energy projection in Table 3 by 8760.

Year	Load (MW) @ cca 20% load factor
1985	205
1990	325
1995	400
2000	450
2005	453

Table 3: Projected New Rail Load (MW)

4.0 ELECTRIC VEHICLES AND RESIDENTIAL APPLICATIONS

The expected average annual rate of growth in demand for electricity in all energy applications until the year 2005, is expected to be 3.8%.

4.1 Introduction

Taking into account the effect of present economic conditions, price increases and conservation, the forecast for residential electric growth is expected to be around 3% per year up until 1993, and 3.25% per annum from 1995 to 2005.

All of the above figures do not take into account any new residential applications that may come on the market between 1982 and 2005.

4.2 New Residential Applications

Sales of television and audio equipment have been flat in North America over the past few years. Consumer electronics companies hope to develop new product lines that will have the same impact on the market as did stereo sound systems and color television. There appears to be a shift toward a new era in personal electronics with strong emphasis on computers and two-way communications.

There are expected to be further dramatic improvements in stereo sound systems and television picture quality and this will be one aspect of a determined drive to turn the home into a sophisticated electronic communications and computing centre.

A number of Hollywood studios are seriously looking at abandoning film in favour of videotape containing high-definition TV signals. These signals could be sent directly to the home and shown on video cassette recorders that integrate stereo sound, thus producing high quality video and audio signals.

With the advent of electronic shopping, electronic mail and newspaper delivery systems for the home, most people will be required to conform to a lifestyle utilizing computer technology. Terminals hooked up to a home TV screen, a modem to provide the necessary interface between terminal and telephone lines, and a printer to put the received messages down on paper, is all that is required to go on line, see Figure 1.

It is envisaged that during the next 20 years, more leisure time will be spent at home and that home entertainment will consist of TV, video games, personal home computers, hot tubs and saunas - all reliant on electrical energy.

In a determination to reduce dependency on oil and to reduce our overall energy operating costs, it is expected that electric vehicles (EV's) will be produced in large quantities in the forthcoming decades.

The EV has been the subject of much debate over the past 20 years, however, they offer good prospects for the future, particularly as gasoline becomes more expensive. Initially, the EV will be more extensively used in metropolitan areas because of their limited cruising ranges which presently can vary from 60 km to 100 km between charges. As battery technology improves, these distances will improve, allowing EV's to be used in rural areas as well.

Residential photovoltaic cogeneration may have an impact on B. C. Hydro's electric grid. The growth of photovoltaic cogeneration is stimulated by a simple economic condition: the price that utilities charge for electricity is rising, while the price of solar photovoltaics is falling. The curves will eventually intersect making the photovoltaic concept a viable alternative. It is estimted that by 1995, the unit price per peak watt for silicon solar cells will be around $1.

4.3 Television

The present energy consumption of a typical TV is approximately 400 kW.h/yr. The new generation of TV's will be more energy efficient with flat screens and be compact and light. With new developments such as high-definition TV picture quality, and the use of TV's as video display units (VDU's) for computers, video games, electronic shopping, etc., the time spent using TV's will inevitably increase.

A recent study done by Arthur D. Little Management Consultants, Cambridge, Mass., indicated that the average person living in North America presently watches 21 hours of TV a week (not taking into account the use of TV's for computers and video games, etc.). Now that the Pay TV concept is operational, more TV programming will be made available (a 12 channel TV set operated around the clock can deliver almost 2,100 hours of programming a week).

This increase in time spent watching TV will offset the energy savings brought on by this new breed of sophisticated energy efficient television sets. As a direct result, the estimated annual energy consumption figure for all TV sets operated per household is expected to increase to approximately 500 kW.h by 1995 and to 600 kW.h by year 2005.

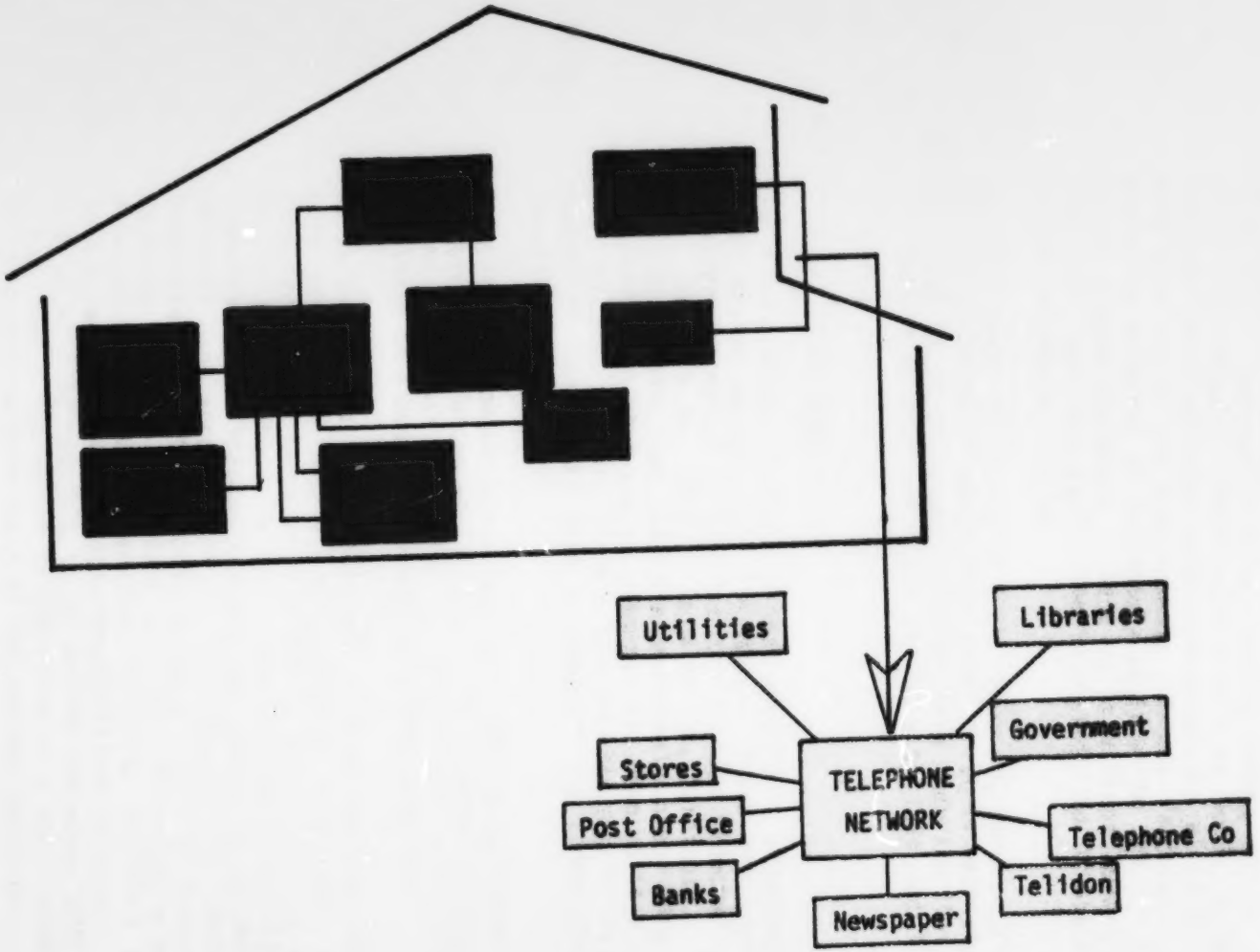


Figure 1 Projected Residential Computer Terminal Hookup

4.4 Video Cassette Recorders

Video cassette recorders (VCR's) will be eventually replaced by video disc recorders (VDR's) which will incorporate laser technology. Instead of using cassette tapes, plastic discs which are virtually indestructible will be used. These new recorders will be packed with communications electronics and have both stereo and quadraphonic playback features. These VDR's are expected to ultimately replace the use of conventional stereo equipment. These units will be more energy efficient, but here again, the increased time of usage will offset the energy savings.

As the present day costs of VCR's diminish, more people will see the benefits of owning such a unit. It is estimated that less than 3% of all homes presently have them and that 20% of all households will own VCR's or VDR's by 1995 and 35% in 2005.

4.5 Personal Home Computers

For a long time, it appeared that electronic shopping would never become established, but today, there are several retailers accepting orders via the Telidon videotex system (e.g. Hudson's Bay Company in Winnipeg, Manitoba). These retailers claim that they are reasonably happy with the interest shown, but are at present, not deeming it a commercial success. The key to this type of shopping is tied to the number of homes that have a computer and communication capability.

Presently, 78 major North American computer equipment manufacturers have accepted Telidon as the standard display format and many analysts claim that the system will eventually become available to almost anyone owning a home computer.

As we enter into a paperless and cashless society, more and more people's lifestyles will require involvement with computer related hardware (eventually nobody will be able to buy or sell without having a national or international computer identification number, for crediting or debiting personal bank accounts, etc.). For the average homeowner to communicate with the outside world, all that is required is a keyboard terminal that links to a home TV screen, a modem to provide the necessary terminal telephone interface and a printer to put the telephone transmissions on paper. Before long it will be possible to go on-line for about $300 total - a sum roughly equivalent to the price of a small color TV set, which is well within reach of the average Canadian.

William Hutchinson, one of Canada's foremost computer consultants, estimates that by the end of this decade, up to 25% of all Canadian homes will have a computer. B. C. will have 570,000 home computers by 1995 and 1,460,000 by 2005 (39% and 80% of all residential accounts respectively).

4.6 Video Games

Video games are thought largely to be responsible for introducing computers into the home. Most video games are bought by or for people between the ages of 8 and 18 years. Many technically curious people are buying the games as a substitute to TV entertainment and the avoidance of boredom. Once the novelty of playing games wears off, most post video game enthusiasts tend to concentrate on the home computer system while still occasionally playing the once popular games. As a result, many computer equipment manufacturers are building machines which have personal computing capabilities as well as being able to accept video game cartridges.

The demand for strictly video game orientated machines will tend to decrease as computer equipment manufacturers build home computers with video game cartridge interfaces.

4.7 Hot Tubs

Many manufacturers of recreational equipment are determining, that instead of buying new homes, many people are finishing a basement or attic and putting in a hot tub or sauna and a few pieces of exercise equipment.

The estimated average annual energy consumption figure to heat an outside hot tub or spa (using an insulating cover) in B. C. is approximately 18,000 kW.h. Even though more leisure time will be spent at home, it is expected that the average hot tub usage time will decrease, thus giving a reduced overall annual energy consumption figure.

Because of the high cost and energy demand for such installations, it is estimated that less than 5% of all homes by the year 2005 will have hot tubs or spas.

4.8 Saunas

Saunas are mainly used by homeowners and tenants in apartment buildings that have swimming pools, hot tubs or spas, etc. It is anticipated that there will be an increase in the number of homes and apartment buildings that will just have saunas (no pools or spas) because of the economics of such units. It is still estimated that less than 5% of all homes by the year 2005 will have saunas.

4.9 Vehicle Transportation

4.9.1 Internal Combustion Engine (ICE) Vehicles

Anticipated increases in ICE passenger cars in B. C. are:

1981 - 1985	3.0% increase/yr
1985 - 1995	2.5% increase/yr
1995 - 2005	1.8% increase/yr

(a) 1981 to 1985

Somewhat less than normal ICE vehicle purchases because of continued tight monetary policy, with high unemployment and families considering only owning one car instead of two or three.

(b) 1985 to 1995

Less than the 1981 to 1985 trend because most families at this stage are one-car families. Increased gasoline prices, large scale sales and service for propane and compressed natural gas (CNG) hybrid vehicles, with initial breakthrough in electric vehicle battery technology, all contributing to a decrease in ICE vehicle sales.

(c) 1995 to 2005

Less than previous time period because of increased gasoline costs, pollution in metropolitan areas, government incentive programs for alternate fuels such as propane, CNG, EV and hydrogen. Expected breakthrough in battery technology, giving EV's a real increase in the total vehicle populuation. Also an increase in shuttle systems for metropolitan areas (bus service, car pools, LRT systems and the use of toll fees for ICE passenger cars using bridges, etc.).

4.9.2 Electric Vehicles (EV's)

Anticipated increase in EV's in North America is shown in Table 4.

Year	U. S.	Canada	B. C.
1981 - 1985	100 K - 400 K	10 K - 40 K	0.6 K - 2.4 K
1985 - 1990	400 K - 1.2 M	40 K - 120 K	2.4 K - 7.2 K
1990 - 1995	1.2 M - 2.5 M	120 K - 250 K	7.2 K - 15.0 K
1995 - 2000	2.5 M - 4.0 M	250 K - 400 K	15.0 K - 24.0 K
2000 - 2005	4.0 M - 6.5 M	400 K - 650 K	24.0 K - 40.0 K

Table 4: Projected Increase in Electric Vehicles

M = million
K = thousand

EV's are not at present being produced in large quantities. Most authorities expect less than 10% of all cars, trucks and buses in North America will be electric by the year 2000.

Recently, further developments in EV's have been actively pursued throughout the world as a result of the pollution concerns of the 1960's; the fuel shortages of the 1970's and 1980's; and the huge business opportunities for industry.

A market for EV's to replace conventional passenger cars, trucks and buses does exist. A recent survey showed that approximately 90% of all daily urban trips in automobiles in North America are less than 35 km. There are approximately 120 million cars in the U. S. and Canada now, of which about 40% are second and third family cars. Half of these are estimated never to exceed the range and speed of currently available EV's.

In Canada, it is estimated that approximately 300,000 to 400,000 EV's will be in service by the end of the century. If 5% of all vehicles in Canada today were electric powered, our national daily petroleum consumption would be cut down by approximately 6.4 million litres. (In B. C. daily consumption would be down to approximately 340,000 litres.) The main reasons for using EV's is to reduce on our dependency on oil and to reduce our overall operating costs.

The best present day application for EV's is for:

(a) commercial fleet trucks and vans. These vehicles often travel shorter distances (mainly city driving) at reduced speeds and are usually parked most of the day. Their key advantages are reduced maintenance, quietness, fuel economy and lack of pollution;

(b) commercial and industrial material handling equipment. Their advantages are good overall economy, low energy costs, quietness and pollution free.

Battery chargers used in EV's would typically be 1.5 kW to 3 kW for cars, 3 kW to 5 kW for trucks and vans and 8 kW to 15 kW for buses. They would trickle charge for typically an eight hour period, probably during an off peak period from 9:00 p.m. to 5:00 a.m. If and when a sufficient number of EV's appear among the vehicle population, a change in rate schedule structuring might occur allowing EV owners to charge their EV's during these off peak periods.

If 350,000 EV's were operating in Canada by the year 2000, the increased electrical load on our national utility grid, as a result of battery chargers would be in the neighborhood of 1,750 MW. This would amount to an increased annual electrical energy consumption figure of approximately 5,000 GW.h. In B. C., our increased annual electrical energy consumption would be in the neighbourhood of 285 GW.h.

Battery technology is the key for the commercialization of the EV. Present batteries have a nominal life span of 18 months to three years. Driving patterns and maintenance practices greatly affect the battery life. The current replacement costs can range anywhere from $500 to $2,000.

4.10 Residential Photovoltaic Cogeneration

The major barrier to photovoltaic acceptance remains the high cost of the system. A report by Frost and Sullivan Consultants, indicates that photovoltaics presently represent a $60 million/year worldwide market. By the year 1990, the total market for complete systems could reach more than $1 billion. By 1995, the market could be more than $2 billion, and then reach $10 billion by 2005. It is estimated that by the year 2005, photovoltaics will be as common as air conditioning is today. The report further states that residential applications will represent 35% of the sales. While, other applications will include: remote sites (16%); water pumping (21%); consumers (2%); intermediate load centres (13%); and utilities (13%).

Residential retrofit arrays will be in the 4 to 8 kWpk size range and the expected system costs will range from $2.00 to $3.00 per total installed peak watt by 1995.

4.11 Low Energy Homes

Energy conservation in the home will be an important issue in the next two decades, as energy prices continue to rise requiring a higher percentage of the average wage. As a result, many homeowners will retrofit their homes thus making them more energy efficient. Most new homes built in the next 20 to 30 years will be of the energy efficient or super energy efficient type to cut down on the space heating load. In this endeavour, it will be noticed that the domestic water heating load and appliance load will become the higher energy consumers of the home. A further attempt to bring these energy costs down will result in an overall energy reduction on the base loads for low energy housing (base loads represent space and water heating loads, lighting and standard appliances without new residential applications).

These new homes will be designed to be light and tight, to minimize heat loss and air leakage. They will feature insulated doors with sealed entry hall and a continuous vapour barrier built into the insulation to seal out drafts. Typical heating systems will be super energy efficient gas furnaces, electric central heating or strictly electric baseboards and will incorporate an air-to-air heat exchanger designed to bring in fresh air. It works by extracting heat from the warm exhaust air and using it to heat incoming cool air.

Space heating energy costs for typical homes built before 1975 amounted to about 60 to 75% of the total energy costs, with domestic water heating costs at around 15%. Low energy homes that are being built today will be continued to be built in the future. Space heating energy costs will be around 40% or less, the domestic water heating costs around 40%, with the remaining 20% taken up by the appliance and lighting loads. It is estimated that the new low energy homes will save up to 80% on space heating energy when compared to present standard conventional homes and will consume, on average in B. C., around 5 kW.h per square foot of living area per year.

4.12 Summary

Description	1981	1985	1990	1995	2000	2005
	MW	MW	MW	MW	MW	MW
Television	156	163	175	193	210	233
VCR's	4.3	12	23	35	46	58
Home Computers	2.4	8	15	23	33	44
Video Games	3.2	4.7	6.5	8	9.7	11
Hot Tubs	13	30	60	113	160	225
Saunas	42	130	280	456	630	780
EV's	1.9	10	35	60	120	200
Totals	223	358	595	888	1209	1551

Table 5: Projected Breakdown in New Residential Loads (MW)

Year	Load (MW)	Projected Load at 0.5 Load Factor
1981	223	111
1985	358	179
1990	595	292
1995	888	444
2000	1209	604
2005	1551	775

Table 6: Projected Total of New Residential Load 1981-2005 (MW)

TABLE 7
NEW RESIDENTIAL APPLICATIONS IMPACT ON B. C. HYDRO'S
ELECTRICAL UTILITY SYSTEM 1981-1995-2005

				1980-82	1995	2005
Population			U. S.	235 million	294 million	363 million
			Canada	23.5 million	29.4 million	36.3 million
			B. C.	2.78 million	3.5 million	4.3 million
ICE Vehicles			U. S.	120 million	172 million	207 million
			Canada	12 million	17.2 million	20.7 million
			B. C.	1 million	1.4 million	1.7 million
EV's			U. S.	< 150 K (880 GW.h/yr)	2.5 million (25,000 GW.h/yr)	6.5 million (78,000 GW.h/yr)
			Canada	< 150 K (88 GW.h/yr)	250 K (2,500 GW.h/yr)	650 K (7,800 GW.h/yr)
			B. C.	<1,000 (5.8 GW.h/yr)	15 K (150 GW.h/yr)	40 K (480 GW.h/yr)
Residential Customers (Without New Residential Applications)	Resd Accts	# of		975 K (100% RA)	1,460 K (100% RA)	1,830 K (100% RA)
		Energy		9,140 kW.h/yr (8,750 GW.h)	8,940 kW.h/yr (12,825 GW.h)	9,450 kW.h/yr (17,300 GW.h)
	Apt/ Condos	# of		350 K (36% wrt RA)	585 K (40% wrt RA)	825 K (45% wrt RA)
	Homes	Total # of		565 K (58% wrt RA)	775 K (53% wrt RA)	880 K (48% wrt RA)
		All Elec	# of	105 K (18% wrt all H)	240 K (31% wrt all H)	300 K (34% wrt all H)
			Sp	7,500 kW.h/yr (46%)	5,300 kW.h/yr (42%)	4,250 kW.h/yr (39%)
			DHW	5,940 kW.h/yr (36%)	4,720 kW.h/yr (38%)	4,500 kW.h/yr (41%)
			Appl	2,000 kW.h/yr (13%)	1,750 kW.h/yr (14%)	1,500 kW.h/yr (14%)
			Ltg	800 kW.h/yr (5%)	750 kW.h/yr (6%)	650 kW.h/yr (6%)
			Total	16,240 kW.h/yr (100%) (1,705 GW.h total)	12,520 kW.h/yr (100%) (3,000 GW.h total)	10,900 kW.h/yr (100%) (3,270 GW.h total)
		Low Enrg	# of	<15 K (2% wrt total H)	180 K (23% wrt total H)	330 K (38% wrt total H)
			Sp	7,000 kW.h/yr (44%)	5,300 kW.h/yr (42%)	4,250 kW.h/yr (39%)
			DHW	5,940 kW.h/yr (38%)	4,720 kW.h/yr (38%)	4,500 kW.h/yr (41%)
			Appl	2,000 kW.h/yr (13%)	1,750 kW.h/yr (14%)	1,500 kW.h/yr (14%)
			Ltg	800 kW.h/yr (5%)	750 kW.h/yr (6%)	650 KW.h/yr (6%)
			Total	15,740 kW.h/yr (100%) (158 GW.h total)	12,520 kW.h/yr (100%) (2,255 GW.h total)	10,900 kW.h/yr (100%) (3,600 GW.h total)
New Residential Applications in B. C.	TV's	# of		780 K (80% of RA)	1,285 K (88% of RA)	1,790 K (98% of RA)
		Enrg/Unit Per Year		400 kW.h/yr	500 kW.h/yr	600 kW.h/yr
		Total Enrg		(312 GW.h)	(642 GW.h)	(1,074 GWh)
	VCR's	# of		29 K (3% of RA)	292 K (20% of RA)	640 K (35% of RA)
		Enrg/Unit Per Year		100 kW.h/yr	125 kW.h/yr	150 kW.h/yr
		(Total Enrg)		(2.9 GW.h)	(36.5 GW.h)	(96 GW.h)
	Compu-ters	# of		49 K (5% of RA)	570 K (39% of RA)	1,460 K (80% of RA)
		Enrg/Unit Per Year		35 kW.h/yr	70 kW.h/yr	90 kW.h/yr
		(Total Enrg)		(1.7 GW.h)	(40 GW.h)	(131 GW.h)
	Video Games	# of		65 K (7% of RA)	200 K (14% of RA)	350 K (19% of RA)
		Enrg/Unit Per Year		35 kW.h/yr	50 kW.h/yr	60 kW.h/yr
		(Total Enrg)		(2.4 GW.h)	(10 GW.h)	(21 GW.h)
	Elect Hot Tubs	# of		1.75 K	15 K	30 K
		Enrg/Unit Per Year		18,000 kW.h/yr	14,000 kW.h/yr	12,000 kW.h/yr
		(Total Enrg)		(32 GW.h)	(210 GW.h)	(360 GW.h)
	Saunas	# of		3.5 K	38 K	65 K
		Enrg/Unit Per Year		2,740 kW.h/yr	2,500 kW.h/yr	2,350 kW.h/yr
		(Total Enrg)		(9.6 GW.h)	(95 GW.h)	(153 GW.h)
	EV's	# of		<1,000 (<0.1% of ICE V)	15 K (1.1% of ICE V)	40 K (2.3% of ICE V)
		Enrg/Unit Per Year		8,760 kW.h/yr	10,000 kW.h/yr	12,000 kW.h/yr
		(Total Enrg)		(5.8 GW.h)	(150 GW.h)	(480 GW.h)
	Total Energy			365 GW.h (1.3% wrt TEE)	1,184 GW.h (2.6% wrt TEE)	2,294 GW.h (3.6% wrt TEE)
(Without New Apps) Resd Base Load				8,750 GW.h	12,825 GW.h	17,300 GW.h
(With New Apps) Total Resd Enrg				9,115 GW.h (32.3% wrt TEE)	14,010 GW.h (30.7% wrt TEE)	19,594 GW.h (31.0% wrt TEE)
Total Elec Energy (TEE) (Ind/Com/Resd)				28,295 GW.h (100%)	46,210 GW.h (100%)	64,300 GW.h (100%)

RA - Residential Accounts
H - Homes
V - Vehicles
EV's - Electric Vehicles
VCR's - Video Cassette Recorders
wrt - With Respect To
TEE - Total Electric Energy (Ind/Com/Resd)
ICE - Internal Combustion Engine

5.0 ELECTRONIC (OFFICE) DEVELOPMENTS

5.1 Introduction

Growth in microcomputer technology is presently accepted as routine. Microelectronics are now fundamental constituent elements of appliances in both home and office environments. The future will see microprocessor-based control systems replaced by microcomputers - effectively performing a similar function but with a greater degree of sophistication.

The electronicization of previously manual tasks leads ultimately to an increased electrical load and consequent requirement for a greater service capacity. (Potential increases in new domestic load are discussed in Section 6 - Low Energy Residences. This section will discuss office load.)

The future of office automation is in little doubt, just as the Industrial Revolution created more production jobs than it eliminated, it is anticipated that the advent of high technology will create new opportunities for all workers. This will involve radical retraining and development of today's labour pool in order that they are able to participate and function positively in an environment previously alien to them - the office. These "new" personnel will help re-shape and re-orient the objectives of the business community and promote an ongoing changeover to an Information Society.

5.2 Office Load

Presently the following equipment may well represent connected office load:

- computers (large mainframe)
- small business computers (mini or micro)
- telephone equipment (PBX)
- data - word processor equipment
- video display terminals
- offset duplicators
- offset platemakers
- spirit duplicators/copiers
- copying machines
- addressing/mailing equipment
- electronic/electric typewriters
- intercoms/paging systems
- electronic mail/facsimile equipment
- security equipment
- dictating machines/equipment
- shredding machines
- refrigerators
- coffee maker/machines
- vending machines

- electric pencil sharpener
- HVAC equipment
- electric kettles
- computer conditioning equipment
- electronic air cleaner
- desk top calculator power supplies
- individual task lighting
- telex terminal
- computer assisted design (CAD) and engineering (CAM) systems
- microfilm equipment
- overhead/slide projector(s)
- incandescent, fluorescent or HID lighting
- emergency lighting
- fire alarm circuits/smoke detectors
- plumbing electrical loads (pumps, etc.)
- miscellaneous fractional horsepower loads (fans, etc.)
- elevators

Future office load will comprise of more of all of the above plus:

- personal data/word processor terminal (executive work station)
- colour printer/photocopier
- electronic mail printer
- fifth generation (voice-activated personal computers)
- building/area network satellite communication equipment

00,000

Figure 2 indicates the office automation market in Canada (Department of Communications Study) and Figure 3 profiles the type and numbers of equipment being purchased for the office in the USA.

From published, installed base and projected figures, the most massive increase in new office load will be from:

- small business computers and power supply equipment
- communicating word processors/data processing equipment
- reprographics - copiers/duplicators
- facsimile terminals - electronic mail
- video monitors/teleconferencing equipment
- lighting load

The main items which will probably constitute the greater part of any increase in office load are:

(a)	data terminals	(200 W)
(b)	electric typewriters	(140 W)
(c)	word processors	(250 W)
(d)	photocopiers	(1300 W average)
(e)	telex terminals	(150 W)
(f)	facsimile transmission	(250 W)

Figure 2 **OFFICE AUTOMATION MARKET IN CANADA INSTALLED BASE & FORECAST (DOC STUDY)**

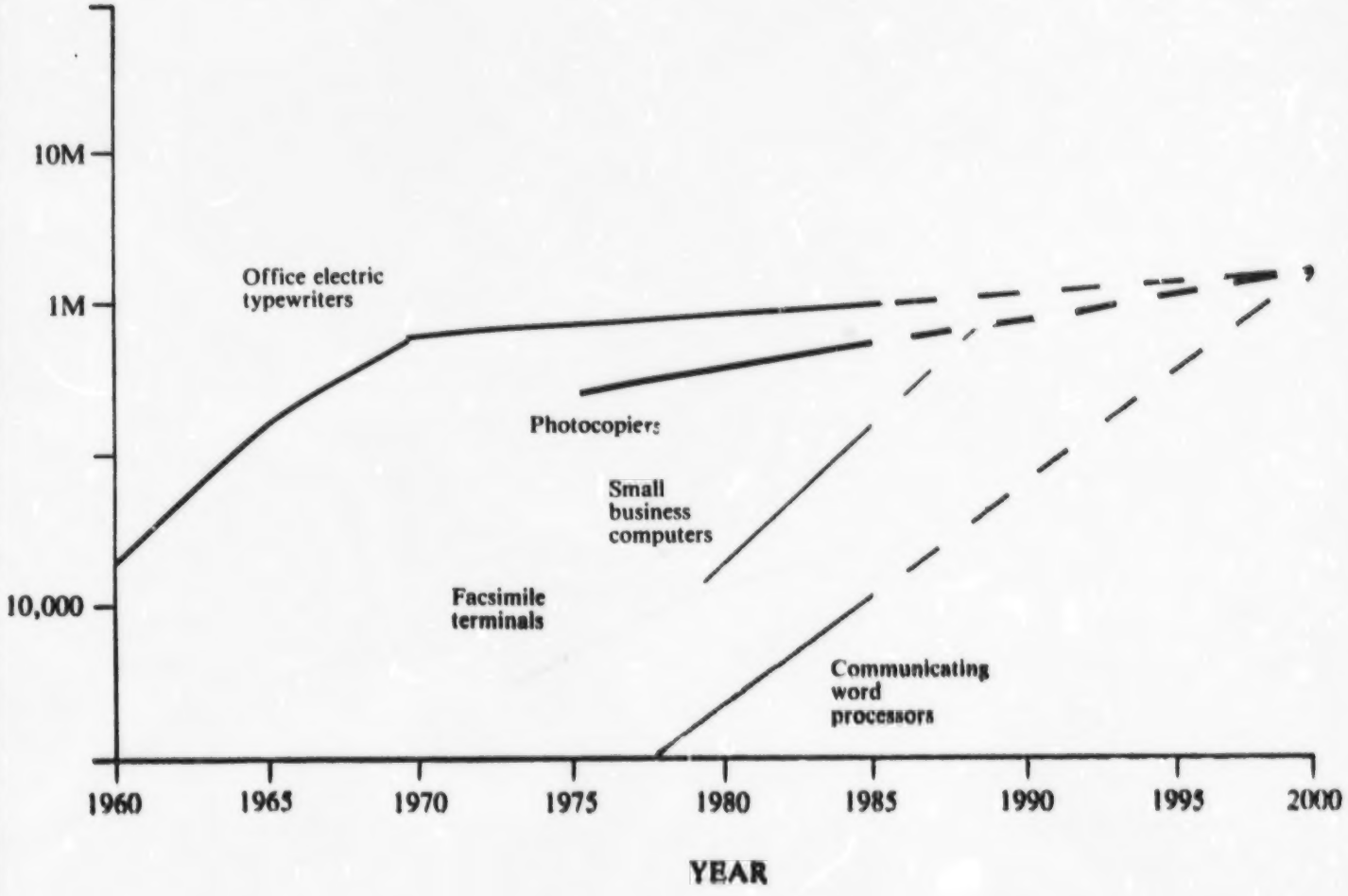
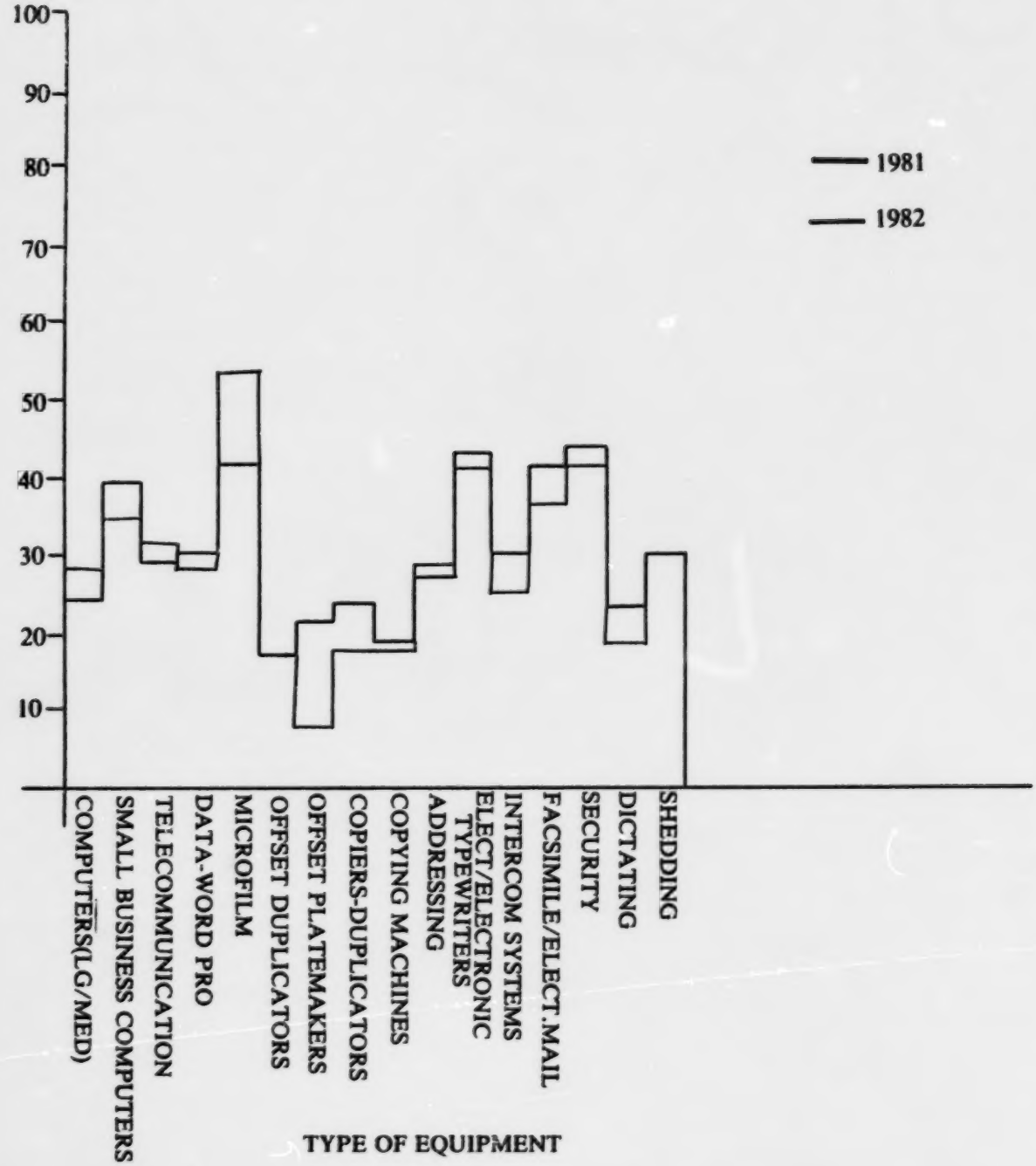


Figure 3. **NEW EQUIPMENT PURCHASING PLANS USA 1981 & 1982**



The net effects of a 15% increase of these loads in B. C. would generate the projections shown in Table 8.

Year	Load (MW)
1985	125.3
1990	173.6
1995	230.0
2000	287.3
2005	338.2

Table 8: Projected New Office Load Totals

The two major items responsible for this increase are word processors and photocopiers.

Canadian population projections prepared by the Institute for Research on Public Policy indicate that there will be approximately 3.2 million extra people in the workforce. Of this 3.2 M, 56% will be men and 44% women. Since more people will be available for work, more will enter the office environment and be available for "new" technology training. Therefore, more office facilities will be required and a greater electrical office lighting and HVAC load will be experienced. Contrary to popular belief, more automation in the office will mean more office personnel and will thus require more HVAC, lighting and space. The HVAC increase will be addressed in Section 7. According to the Office Automation Report compiled for the Canadian Institute for Research on Public Policy, indications are that between 1979 and 1985, 1.02 million m^2 of extra office space will be available in B. C. if huge growth occurs, an increase of 1.36×10^6 m^2 could occur. This extra office space impacts lighting requirements.

If we assume 1 luminaire (2-tube) per m^2, we have:

$$1.36 \times 40 \times 2 \times 10^6 = 108.8 \text{ MW of extra lighting.}$$

By 2005 it could well be close to 120 MW.

Therefore the total extra office load projected for B. C. comprises of; new existing technology, new (and as yet) unimplemented technology, HVAC and lighting.

5.3 Summary

The net overall effects of office automation on society may be summarized as follows:

(a) there will be unemployment for some (redundancy);
(b) it allows some operators to work at home;
(c) new jobs will be created;
(d) some jobs will be eliminated;
(e) new careers (particularly in data processing) will emerge;
(f) middle management will further develop and job opportunities increase;
(g) there will be a general reduction in number of clerks/secretaries, i.e. office support staff;
(h) net effect on the province will be a progressive redundancy, retraining of the labour force as automation progresses;
(i) people will retrain to become "information workers".

The office routine will change in the following manner:

(a) work habits will vary as more people becoming proficient with new technologies;
(b) daily travel to and from office will be cut down, i.e. people travelling less distance to work;
(c) more people in the office will mean increased facilities.

Essentially, more people will be available for "new" technology means more office facilities are required, consequently a greater electrical load is forecast. Table 9 summarises the total contribution made by new office load through to 2005.

Year	New Office Load (MW)	New Lighting Load (MW)	Total New Load (MW)
1985	125	108	233
1990	174	111	285
1995	230	114	344
2000	287	117	404
2005	338	120	458

Table 9: Total Projected New Office Loads

6.0 ENVIRONMENTAL CONTROL/WASTE MANAGEMENT

6.1 Introduction

This part of the study has two aims:

(a) To determine the percentage of electrical consumption in B. C. that is related to the implementation of regulatory environmental controls.

(b) Examine the possible upgrading of pollution standards and controls and extrapolate over five to ten years the effect on the future load forecast.

Initially, it was assumed that the collection of information from industry would not be too difficult, however, that has not proven to be the case. Representatives of industry have generally been extremely reluctant to provide the information requested. Quite often personnel with large companies were not aware as to who would be able to provide the information requested.

Due perhaps to the current downturn in the economy there does not seem to be any indications of more stringent pollution control standards. Most industries indicate that they have installed pollution emmission control equipment in excess of the regulatory requirements. In some cases, this is due to voluntary modernization programs, i.e. Chevron and Shellburn refineries in Burnaby - and they claim confidence in meeting or surpassing regulatory standards for the forseeable future.

In 1973 a study conducted by the Electrical Energy Association in the United States in collaboration with 87 electric utilities came up with some interesting figures (Appendix 1).

The returns to the EEA show that 2,100 customers used 8.8 billion kW.h for pollution control in 1971. These kW.h represented 7.3% of the total annual electrical requirements in that year. During 1972, the same customers expected to use 11.7 billion kW.h for pollution control. By 1977, they expected an average annual electrical use exclusively for pollution control of 20.4 billion kW.h representing about 10% of the overall annual needs.

Of the 29 classifications listed, waste recycling and sewage treatment show the highest percentage of electrical energy used for pollution control. With waste recycling, it is safe to assume the process will produce a useable end product with sewage treatment and with some exceptions 100% of the process is related to environmental control.

The EEA survey shows that retail stores use 1.3% of their total electrical energy consumption for pollution control. A spot check with some department stores and small stores indicates that no electrical energy or a very low consumption related to environmental control. Most mention that the amount consumed is almost immeasurable related to the total load. The same information is reflected by hotel sources.

With the information gathered so far it would be impossible to accurately forecast the electrical energy consumption or to extrapolate for say five years. In all cases, people contacted do not expect any significant increase in their electric consumption for pollution control in the forseeable future.

If those sentiments expressed are correct, then we would have no reason to concern ourselves with a study to show any extra amount of electrical energy consumed for pollution control in the next five years. It should be reiterated that the sample taken was very small and if this aspect of the impact study is to be continued, then a much deeper and broader approach must be taken. For instance, a specially prepared survey questionnaire produced and mailed to our industrial and large commercial customers.

6.2 Results

The survey carried out so far is a rather cursory check and should not be construed as being conclusive. I have strong doubts as to its effectiveness in using the results to determine future electric load. This is particularly so if the comments from respondents are accurate and they do not foresee any upgrading of pollution standards on the horizon.

The total industrial energy consumption for B. C. Hydro customers is 18,512.95 GW.h. However, all B. C. Hydro industrial customers cannot be considered as pollution producers. For instance, shopping centres, real estate, education, religious organizations, etc.

By separating the pollution producing type industry from what may be considered environmentally clean industry, Table 10 indicates that 6.3% of the total electrical energy used in industry is used for pollution control.

Pollution type industry	-	11,709.75 GW.h
Clean type industry	-	6,803.20 GW.h
Total industrial electrical consumption	-	18,512.95 GW.h
Applying the 10% to the pollution producing industry, we get	-	1,170.97 GW.h

This represents 6.3% of the total electrical energy consumption of industry.

Chevron Refinery	* 12.00%	
Shellburn Refinery	5.56%	
Dow Chemicals	13.30%	
GVS DD (sewage control)	100.00%	
Pan Ready Poultry	6.60%	
Belkin Paper	1.90%	
Eatons	0.00%	
The Bay	0.00%	
Sauder Industries (Plastic)	4.30%	
Sheraton Villa (Hotel)	0.00%	
Refinery and Coal	** 8.00%	27.3 GW.h
Chemical Products	12.00%	139.6 GW.h
Paper	5.00%	233.3 GW.h
Food Processing and Beverage	6.50%	33.2 GW.h
Plastics and Rubber	4.30%	1.4 GW.h

Table 10: Typical Percentage of Electrical Energy Used in Pollution Control in B. C.

* Represents total percent of electrical consumption to implement pollution controls for individual companies.

** Represents percent on an industry basis.

The Greater Vancouver Sewerage District provides collection and sewage treatment plants for its member municipalities. For the year 1981 total electrical consumption to provide the service was 43,054,307 kW.h.

Population served by GVRD = 1,100,000

Population of B. C. = 2,467,000

If we extrapolate the GVRD per capita consumption over the B. C. population assuming a similar consumption/service, the B. C. electrical consumption for sewerage treatment is 96,559,068 kW.h. In conclusion, we can elucidate from accepted norms, that 6.3% of the electrical industrial base forecast will be required for pollution control.

We can now obtain an estimate for the projected demand of this equipment through to 2005. Table 11 indicates this demand.

Year	Total Projected Sales (GW.h)	Projected Peak Demand (MW)	Projected Industrial Peak Demand** (MW)	Projected Pollution Equipment Demand*** (MW)
1980/1981	3,952	5,475	2,354	148.3
1984/1985	41,335	7,280	3,130	197
1989/1990	52,420	9,130	3,926	247
1994/1995	64,500	11,420	4,910	309
1999/2000	76,900	13,650	5,867	369
2001/2002	81,900	14,590	6,273	395
*2004/2005	89,400	16,000	6,880	433

Table 11: Projected Load of Pollution Control Equipment

Source: Table E2, Projections of Gross Load Requirements, p.20, B. C. Hydro, September 1981.

* Figures extrapolated from earlier years, not part of Table E2.
** Industrial demand taken as 43% of B. C. Hydro total load.
*** Pollution equipment taken as 6.3% of B. C. Hydro total industrial load.

7.0 HVAC AND CANADIAN OIL SUBSTITUTION PLAN

7.1 Introduction

Several residential heating impact studies have been completed, each one forecasting reductions in average energy consumption per household due to various energy conservation measures. However, there are some strategies directly involved with residential heating that will result in increased electrical consumption, most notably:

- continuous furnace fan operation;
- air-to-air heat exchanger fan motors;
- hybrid heat pumps;
- off-oil to electric heating;
- residential air conditioning.

This section presents an estimate of the impact of these factors.

7.2. Continuous Furnace Fan Operation

Newer homes will be more effectively sealed than present housing stock, resulting in less infiltration. Occupants of low infiltration homes will be more inclined to leave the furnace fan running continuously to alleviate stuffiness, as well as distribute solar gains and localized internal gains throughout the house.

The extra electrical consumption for continuous fan operation is estimated to be 750 kW.h/yr for each household adopting this practice.

Furnace fan operation is considered relevant only in gas, oil or propane heated housing, since the number of electric furnace installations is negligible and electric heat pumps have been considered in Projects 7812 and 7857.

The number of electrically heated and non-electrically heated dwellings is contained in Table 12.

	Pre-1980	1985	1990	1995	2005
Electric	108,302	166,200	223,400	278,000	350,000
Non-Electric	774,621	866,800	999,600	1,041,000	1,085,000
Total	882,923	1,033,000	1,223,000	1,319,000	1,435,000

Table 12: Residential Heating Accounts

It has been assumed that if a home is not electrically heated, it is heated by natural gas, oil or propane. The number of future houses heated with none of these fuels (i.e. those heated by wood or coal) will be negligible. Those that use supplemental wood heat will be inclined to leave their furnace fans running to circulate heat throughout the house, and this has been considered when determining households using continuous fan operation.

The percentage of households using continuous fan operation is expected to vary with the construction standards of the house, with improving standards leading to greater use of continuous fan operation. Table 13 is an estimate of the percentage of households (gas, oil or propane heated) that will practice continuous fan operation.

Forecast Year	1985	1995	2005
Year of Construction			
Pre-1980	5	5	5
80-85	15	15	15
85-90	25	25	
90-95	40	40	
95-2005		50	

Table 13: Penetration of Continuous Fan Operation

The average consumption per electric account has been calculated as follows:

$$1985 - \frac{750}{1033000} [.05\ (774621) + 0.15\ (866800 - 774621)]$$

$$= 38 \text{ kW.h/yr}$$

Consumption for other years and forecasts are calculated in a similar manner and are contained in Table 14.

Forecast Year	1985	1995	2005
kW.h/yr	38	58	66

Table 14: Additional Consumption per Account Due to Continuous Fan Operation Normalized Over All Residential Electric Accounts

7.3 Air-to-Air Heat Exchanger Fans

Fan motors on air-to-air heat exchangers draw, on average, 150 W. Some would operate continuously during the heating season (approximately 5,000 hours/year) while others would operate on demand from a humidistat, thus operating approximately 2,000 hours/year. Average operating time has been estimated to be 3,000 hours/year, thus consuming 450 kW.h/year.

The penetration of air-to-air heat exchangers into gas heated homes served by B. C. Hydro Gas has been estimated in Project 7859. These penetration values are considered applicable to all gas and oil heated housing in the province.

The electrical load created by air-to-air heat exchangers in electrically heated housing is essentially recovered as heat, and has been included in Project 7857.

The additional electrical consumption due to air-to-air heat exchanger fans in gas and oil heated housing is given in Table 15.

Forecast Year	1985	1995	2005
kW.h/yr	0	0	6

Table 15: Additional Consumption per Account Due to Air-to-Air Heat Exchanger Fans Normalized Over All Residential Electric Accounts

7.4 Hybrid Heat Pumps

Projects 7812 and 7857 dealt with heat pumps with electric backup, but did not take into account hybrid heat pump installations that use oil, propane or natural gas as backup. Such installations will reduce fossil fuel consumption for heating, but will increase electrical consumption. Hybrid heat pump installations will predominantly be conversions of existing oil or propane furnaces and each installation is estimated to consume 10,000 kW.h/yr.

The number of hybrid heat pump installations and the electrical consumption normalized over all Hydro accounts is contained in Table 16.

Forecast Year	1985	1995	2005
Number of Installations	5,000	10,000	14,000
Consumption/ Acct	48	76	98

Table 16: Number of Hybrid Heat Pumps and Additional Consumption Normalized Over All Residential Electric Accounts kW.h/yr

7.5 Conversions to Electric Heat (Off-Oil Program)

Conversions from oil to electric heating are currently eligible for the COSP grant, except on Vancouver Island, although it is expected that eligibility will be extended to Vancouver Island upon completion of the Dunsmuir-Cheekeye transmission line. It is also anticipated that natural gas will be available to 70% of households on Vancouver Island by 1986/87. It is estimated that there will be a pool of approximately 80,000 oil heated homes in B. C. unable or unwilling to convert to natural gas, but with the option of converting to hybrid heat pumps, plenum heaters or electric furnaces. The weighted average electrical consumption of all converted houses is estimated at 17,500 kW.h. Hybrid heat pump conversions are estimated in Section 3; potential conversions to other forms of electric heat, percentage penetration and additional consumption normalized over all residential electrical accounts are given in Table 17.

Forecast Year	1985	1995	2005
Conversions to Hybrid Heat Pumps (1000's)	5	10	14
Eligible for Conversion to Other Forms of Electric Heating (1000's)	75	70	66
% Penetration to Other Forms of Electric Heating	5	20	40
Consumption/ Acct	64	185	322

Table 17: Residential Off-Oil to Electric Heating Conversions and Additional Consumption Normalized Over All Residential Electric Accounts - KW.h/yr

7.6 Residential Air Conditioning

One of the attractive features of a heat pump is that it can be reversed to provide summer cooling. There is also expected to be modest growth in conventional residential air conditioning systems. Average annual consumption for air conditioning purposes in B. C. is estimated to be 500 kW.h/yr per air conditioning unit.

Table 18 contains estimations of the number of air conditioning installations and their impact on electrical consumption.

Year	1985	1995	2005
All Electric Heat Pumps	600	6,600	20,100
Hybrid Heat Pumps	5,000	10,000	14,000
A/C Systems	200	600	1,400
Total	5,800	17,200	35,500
Consumption/ Account	3	7	12

Table 18: Residential Air Conditioning Installations and Consumption Normalized Over All Residential Electrical Accounts - kW.h/yr

7.7 Summary

Year	1985	1995	2005
Continuous Furnace Fan Operation	38	58	66
Air-to-Air Heat Exchanger Fans	0	0	6
Hybrid Heat Pumps	48	76	98
Oil to Elec Htg	64	185	322
Air Conditioners	3	7	12
Total	153	326	504

Table 19: Increases in Consumption per Account Due to Heating and Air Conditioning Systems All Hydro - kW.h/yr.

Year	Projected Demand (MW)
1985	21
1990	40
1995	60
2000	76
2005	99

Table 20: Projected Increase in HVAC Demand

8.0 LARGE INDUSTRIAL PROCESSES

8.1 Introduction

The techniques of data processing and planning are common to all corporations, irrespective of sector or function, even though there may be detailed differences in the balance of applications. There would appear to be no similar commonality in the uses of computing to control industrial processes, and as a consequence the rate of development of this type of use has been much slower.

The major advancements in process automation and robot technology have occurred in recent years because of the proliferation of micro chips. This trend will eventually result in large productivity improvements in industry and increases in production capacity.

Automation equipment is now economically viable for a wide range of industrial processes and operations and is being introduced into a variety of new environments. Usually computer control has been adopted to overcome some specific problem. For example, in the catalytic cracking of crude, the problem is the variation in the raw materials; in heterogenous phase catalysed petrochemical reaction, the time constants are too short for effective human intervention; in the production of cement or the continuous casting of steel, high economic return can only be obtained if the plant is very efficient.

In the case of batch production, the economic incentive for computer control has been much less. Where computer control has been adopted, it is often for other reasons, for example to obtain the necessary precision in aerospace part machining, or to reduce risk to human life in hazardous environments like nuclear engineering.

Numerically controlled (NC) machine tools have not been widely adopted. In part this has been due to the large increase in productivity possible with NC tools, which can lead to an imbalance in scheduling across a machine shop; and in part it has been due to the high cost of NC tools, which cannot be justified given the small volume and jobbing nature of many small engineering firms.

The objective of this section is to examine the potential applications of automation and robotization and new process applications, and to assess their impact on B. C. Hydro's electrical requirements for the period 1985 to 2005.

Automation and robotization in the long-term is expected to reduce the energy requirements for most production processes because of the more rapid production rates and optimized manufacturing methods. This adds up to improved productivity.

The impact of these changes on our energy demands will vary from industry to industry and will require individual examination. The effects of the world market for the products we produce now, and those which we can anticipate producing in the next 20 years, will also have to be considered in this analysis.

8.2 Industrial Electrical Consumption

The industrial electrical energy sales in B. C. Hydro's service area in 1982 amounted to 18,513 GW.h (million kW.h) and represented 68% of total sales. Appendix C contains the Energy Consumption Distribution by Industry Classification derived from the Industrial Consumption Analysis Program (ICA). In this classification system, "Industrial" signifies all non-residential use categories, i.e. industrial process, agricultural, commercial and institutional.

The major industrial use categories representing 55% of the total industrial energy consumption are:

(a) Paper and Allied Products;
(b) Wood;
(c) Mines; and,
(d) Chemical and Chemical Products.

Figure 4 shown below indicates the percentage breakdown of the 18,513 GW.h of industrial and commercial energy sales in B. C. for 1982.

Figure 4
B. C. Hydro Industrial Electrical Sales
in 1982 - 18,513 GW.h

8.3 Paper and Allied Industries

Paper and allied industries purchased 4666 GW.h of electricity from B. C. Hydro in 1982. This represented 25.21% of the Industrial Energy Sales.

Several different processes are currently being used in the manufacture of mechanical pulp each requiring different quantities of electricity for production. The current average unit consumptions are as follows:

Type	kW.h/tonne
Stone Groundwood	1975
Chemi thermal mechanical pulp (CTMP)	1700
Thermal mechanical pulp (TMP)	2200
Refiner mechanical pulp (RMP)	2400

It is forecast that the production of stone groundwood will decrease annually to zero by the year 2000. RMP will probably remain fairly stable for the same period, while TMP & CTMP will rise rapidly in production to the end of the century. Bearing the above figures in mind and being able to forecast the future production levels of mechanical pulp will enable us to forecast future electrical requirements for this industry.

Developments in the pulp and paper industry for which the technology is available but which have not been adopted in B. C. will be examined.

(a) Displacement Bleaching

Displacement bleaching involves the use of one tower to accomplish four or five stages of bleaching which would have required one separate tower per stage previously. The net saving achievable by the use of displacement bleaching is estimated at 35 kW.h/ADT.*

Displacement bleaching will likely be incorporated into new mills. It may also be applied in some existing pulp mills where bleach plants have deteriorated beyond the point of economical repair.

(b) Recycling Newsprint

The recycling of newsprint is only expected to have a marginal percentage of the newsprint production in B. C. in the next two decades. Newsprint produced by recycling results in a marginal decrease in energy per tonne. Therefore although this production method will decrease energy use, the net effect on electrical demand will be negligible.

8.4 Wood Industry

The main energy source used in the wood industry is electrical. The energy drives electric motors which convey, cut, sort and plane lumber. Changes in production techniques are likely to be of a control nature which could fine tune operations for optimum efficiency. These changes are expected to result in reduced electrical consumption per unit of product produced and were taken into account in the B. C. Hydro Electrical Motor Energy Conservation Impact Report #7854.

In 1982 the wood industry accounted for 1506 GW.h or 8.13% of the Industrial Electrical Energy purchased from B. C. Hydro.

8.5 Chemical Industry

The chemical and chemical product industries in B. C. include the manufacture of fertilizers, resins, plastics, paints, soap, industrial chemicals (caustic soda and chlorine), and pharmaceuticals.

The chemical and chemical products industries purchased 1663 GW.h of electricity from B. C. Hydro in 1982. This represents 6.28% of the industrial electrical sales.

The industrial chemicals which account for about half of the value of the chemical industry and use about 94% of the energy of this industry are nearly all used in the pulp and paper industry. Fertilizer manufacture, the other large chemical industry, is controlled mainly by Cominco at Trail and Kimberley.

Chlorine and sodium hydroxide are produced by the electrolysis of brine. The main energy demands are: electric power for electrolysis and motive power for refrigerating and compressing the gas.

The fertilizer base requiring most energy for its manufacture is ammonia. Natural gas is used as a raw material for ammonia production. Process heat in the form of steam is used to convert the natural gas via a series of processes into liquefied ammonia. The fertilizer ammonium nitrate is then produced by chemical reaction between the ammonia and nitric acid.

The other fertilizers - potassium chloride and superphosphates - require very little energy for their production and are not considered here.

Little change in energy requirements are anticipated for these processes because of new developments. Electrical energy reduction in some of these will result because of efficiency improvements and would have been covered in the E. C. Impact Studies.

* ADT Air Dried Tonne.

8.6 Metal Mining

Metal mining in B. C. in dominated by large, open-pit copper/ molybdenum types of operation. In 1982 B. C. Hydro sales for mines and quarries amounted to 2877 GW.h or 15.54% of the industrial electrical sales.

Electricity is the major form of energy used in mines. It is used predominantly for the milling process to crush and grind the ore prior to flotation. Other significant uses of electricity are: electric shovels in pits, hoisting ore in underground mines, conveying ore, electrically operated drills, air circulation in underground mines and for lighting and heating.

Technological change besides that which has been estimated for the EC Impact Studies is not expected to result in any drastic change to consumption.

Studies for new mines would have to be conducted for individual operations.

8.7 Coal Mining

B. C. Hydro has estimated that the average amount of electricity consumed for coal mining is 32 kW.h/tonne in 1980. Because of higher stripping ratios and an increase in the use of electrical conveyor systems, the average electricity consumption for coal mining by 1990 is expected to reach 40 kW.h/tonne. For the period 1990 to 2005 only marginal increases in the unit electricity energy use is anticipated.

8.8 Cement Industry

This industry represents about 62% of the total energy used by the non-metallic mineral products group which accounted for 266 GW.h/yr in 1982, (1.44% of total industrial electricity sales by B. C. Hydro).

There are two processes used in the manufacture of cement; the wet process which uses 122 kW.h/ton, and the dry process which uses 135 kW.h/ton. The wet process is commonly used today, but the dry process, although it uses 10% more electricity, can potentially save 40% of the natural gas use if pre-heat is incorporated. New cement plants that are built are expected to use the dry process.

8.9 Summary

The reduction in cost of computing equipment does little to remove the barriers to the adoption of current forms of computer control. The computer represents only a small part of the required investment, which is dominated by instrumentation and systems development costs.

What it does do is to open a new approach to industrial automation based on the piecemeal improvement of plant using intelligent instrumentation or local microcomputer control to improve some sub-system. A wide variety of "smart" instrumentation products incorporating microcomputers is already becoming available, and although most of these instruments are currently oriented to human operation, it is to be expected that an increasing proportion will be designed for autonomous operation with data-communication capability. The addition of a microcomputer enables a variety of improvements to be made to an instrument.

Piecemeal automation may be expected to stimulate the application of computer control to existing plant. This is particularly relevant to public utilities where the distinction between continuous processes and production scheduling is blurred, since demand varies continuously but supply is controlled incrementally. Because of the extent of investment in established technology, and the high cost of providing reserve capacity to cater for peak load, it is probable that the current trend to providing more real time responsiveness on the supply side, and the balancing of supply resource allocation by computer will be accompanied by the use of marginal pricing mechanisms to produce more uniform demand and therefore more overall optimal use of resources. In this way, it should be possible to stretch the existing investment to support a much higher level of average activity. These concepts are relevant to utilities like electricity, telecommunications and road networks and could lead to a reduced demand by these utilities for capital investment while the latent capacity is exploited with the aid of microelectronics.

The concept of automation is usually associated with automatic manipulation and assembly techniques. The replacement of the human in such situations requires either a high degree of robotic sophistication, or radical re-design of products and techniques. The development of effective robotic devices is regarded as a hard robotic problem while radical product re-design is not readily assimilated. For these reasons, the introduction of highly automated assembly techniques is expected to be relatively slow. Again, the piecemeal approach is likely to apply, with certain limited tasks being taken over by computer control, thereby reducing the need for human intervention without eliminating it altogether. Robotic systems like car body paint sprayers, based on programmed learning by following human actions, will decline in cost and so become more widely used. The development of adaptive operation in such devices, as contrasted to the current mode of operation which is purely repetitive, is unlikely to be feasible at more than a trivial level until the long term.

8.10 Conclusions

The progress towards automation has been much slower than expected. There have been various reasons for this:

- the theoretical difficulties associated with developing total control systems and robotic devices;
- the disparity between applications, which makes generalized techniques inappropriate;
- the cost barrier, which has meant that computer control was only applicable to large systems and therefore had to tackle inherently difficult problems and achieve larger economies;
- the feared, or actual, social consequences of introduction of automation, associated with other radical changes into areas where the workforce was often well organized.

The developing technology does not solve these problems. However, by reducing the cost of computer control, it does open the way to piecemeal automation and bring down the level of improvement necessary to make automation worthwhile. Gradual automation has the potential to be more acceptable to the workforce, since it does not cause the same upsets in job content nor dysfunctions in employment. Even so, the fear of automation is likely to remain, and likely to act as a powerful brake on its introduction.

In the future it is expected that progress towards automation will continue to be slow, even though the development in micro-electronics makes it more attractive. Progress is also likely to be very uneven between industries, because of the specialized nature of much automation, and the dependence of many of the barriers on the type of industry concerned. It is to be expected that the direct employment consequences will be small, although the indirect consequences (as improved efficiency reduces the need for new investment) could be larger. Even so, less than 20% are employed in actual manufacturing operations, so that the overall consequences for employment are not very great.

The principal applications for robots occur in the electronics' industry, automobile production, plastics and metal working. These industries are in their infancy in British Columbia and their electricity requirements are not expected to have any significant impact in the foreseeable future.

9.0 MISCELLANEOUS INNOVATIVE INDUSTRIAL LOADS

9.1 Introduction

Industry is faced with a shrinking but increasingly expensive resource base with escalating costs in the areas of labour, materials and energy. Without the introduction of new innovative technology, productivity will drop severely in the next twenty years. Innovation is the key to increased productivity.

Innovation in the industrial context has a very precise meaning. It means "the introduction of a method that is inherently less costly than its predecessor because it cuts or eliminates outright certain costs that are intrinsic to the old process".

The innovative process results in a product being produced more economically, quicker and better by improving the basic production method. Modern technological advancements aimed at increased productivity tend to replace expensive human labour with automated labour, computer technology and robotics - all more energy intensive.

This section investigates present and future developments expected for innovative technology and projects the amount of energy these advancements will require.

There is a trend towards use of electrical energy rather than direct fuel combustion to drive industrial processes.

Electricity can ease the requirements and dependance upon fossil fuels. While at the present time, heat energy for industrial process can be more economically purchased in other forms; i.e. $4 per million BTU for gas, $8 for oil compare with $15 for electricity, electricity can be channelled directly and instantly into useful work. Energy conversion through burning fuel necessitates atmospheric heat gain. Consequently, electrical energy is more efficient than other energy forms for many tasks.

Advantages:

(a) Control - electrical energy can be applied and controlled in precise amounts for precise periods of time. Laser technology is one new innovative example.

(b) Intense Heat - fuel combustion can provide 5,000°F while temperatures over 10,000°F are possible with electric heating processes. This high temperature capacity can be a way to reduce production line costs.

9.2 Steel Production

Production of steel utilizing electric induction heating rather than conventional gas-fired combustion furnaces is more energy efficient and cost effective. The American Iron & Steel Institute estimates that electric steel making will grow by more than 50% in U.S. by 1983.

Cost for Steel Production	Combustion Furnace	Electric Induction Process	Savings
Capital cost of steel mill	$1,500	$250	83%

Table 21: Anticipated Energy Savings in Steel Production

A further innovation in the steel industry is Plasma-ore reduction. This method uses electricity to generate plasma - a very hot electrically charged gas which triggers a rapid chemical reaction in iron ore upon exposure and separates the iron from the ore's waste products. The capital cost of the small plasma reduction units is $150/ton/year in contrast to $360/ton/year for conventional combustion blast furnaces.

9.3 Glass Industry

The advantages of high temperature electric melting can boost overall yields from glass furnaces. Percentage yields of 90% or better are expected from electric melting compared to 65-80% for conventional systems.

9.4 Auto Industry

To achieve higher productivity the auto industry has moved to electrification of many of the process technologies. Typically, the electrical energy used to produce an auto has increased by 3% per year over the past decade while material gas use has fallen.

General Motors, recognizing the benefits of electricity in high temperature applications will increase their electrical high temperature process applications from 25% to 70% by 1990.

Electron beam welding is replacing oxy-acetylene torch welding in the auto industry. The typical new car contains about 190 electron beam welds.

Laser beams are also being used to applications from cutting fabric for seats and stripping insulation off wires, to cutting steel.

Year	Energy Used	# Vehicles	Energy Cost/Vehicle
1972	206×10^{12} BTU	6.2×10^{6}	33×10^{6} BTU
1979	200×10^{12} BTU	7.3×10^{6}	27×10^{6} BTU

Table 22: Energy Consumption to Produce Vehicles (General Motors)

9.5 Beverage Industry

Ultraviolet cleaning of beer cans can save 40% over the comparable cost of gas-fired system. An added advantage is that it requires 25% of the maintenance and occupies 10% of the floor space.

9.6 Microwave Heating and Drying

The principle is similar to that of the home microwave oven. When water molecules are exposed to an electric field, they move back and forth with changes in the direction of current. This oscillation produces rapid heating and drying of a water-containing substance.

Possible applications are in lumber drying and the food industry. Microwave drying of hardwood costs $40/thousand board feet compared with $55 for conventional kiln drying. An added advantage is reduction in drying time from 25 days to one day.

The paper industry is also considering drying wood pulp by this method.

9.7 Summary

An increasing number of industries are finding that new electrical technologies offer lower costs and higher productivity in manufacturing. The move to revitalize productive capacity is already in progress. The increased use of electrical energy to achieve this goal is inevitable.

10.0 RECREATION FACILITY USAGE

Increased automation and changing job roles will bring about greater individual leisure time. This time will be split between home and some type of external recreational facility, be it an ice arena, library or gymnasium. The home aspect of recreation is dealt with in Section 4, while this section addresses other types of facility usage.

A greater requirement for recreational facility would necessarily demand more electrical energy for lights, HVAC, snow melting, compressors, etc.

The bulk of the recreational facilities in B. C. is made up of:

(a) ice arenas;
(b) recreational centres;
(c) outdoor fields lighted and unlighted;
(d) swimming pools (outside)
(e) swimming pools (inside)
(f) private health/fitness clubs;
(g) racquet clubs.

Provincial recreational authorities indicate that B. C. has essentially met the demand for facilities and few, if any, new projects are to be funded in the next 20 years. This decision is dependent upon a number of factors, primarily political ones. Recreational facility development and funding apparently is a useful appeaser in times of an election. Notwithstanding the uncertainty of provincial elections, a spokesperson from the Ministry of Recreation and Sport indicated that most B. C. communities had a sufficient facility level and further expansion is not envisaged. In fact, a shrinkage in the number and level of facilities is anticipated, with the only new work being renovation or rebuilding of existing installations.

Thus the net impact of new recreational facilities in B. C. on service requirements is condensed to be effectively zero. A new provincial administration or a significant number of new resource towns (such as Tumbler Ridge) during the next 20 years will of course alter this present view. But given the present economic climate and projected provincial population growth, it would be exceedingly optimistic to prophesize any substantial increased service need due to recreational facilities.

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APPENDICES

APPENDIX A

TABLE A1
CANADIAN POPULATION PROJECTIONS

The following forecasts were prepared for this study by John Kettle in September 1980.

1980	23,838,000	23,859,000
1985	24,621,000	24,887,000
1990	25,189,000	25,969,000
1995	25,514,000	27,071,000
2000	25,611,000	28,203,000

TABLE A2
LABOUR FORCE FORECAST A

(Assuming stable fertility, rising immigration and a slowdown in the increase of the female participation rate).

	15-19	20-24	25-34	35-44	45-54	55-64	65 +	TOTAL LABOUR FORCE	
1980									
MEN	637	997	1920	1405	1145	759	145		11,453
WOMEN	534	804	1197	853	639	361	57		
1985									
MEN	574	980	2079	1646	1204	790	153		12,233
WOMEN	481	793	1335	1051	696	388	63		
1990									
MEN	543	934	2130	1850	1343	823	158		12,929
WOMEN	455	769	1407	1227	808	416	67		
1995									
MEN	538	910	2118	1989	1511	886	161		13,607
WOMEN	450	764	1444	1360	941	464	71		
2000									
MEN	545	913	2105	2062	1662	976	164		14,271
WOMEN	456	793	1485	1450	1066	529	75		

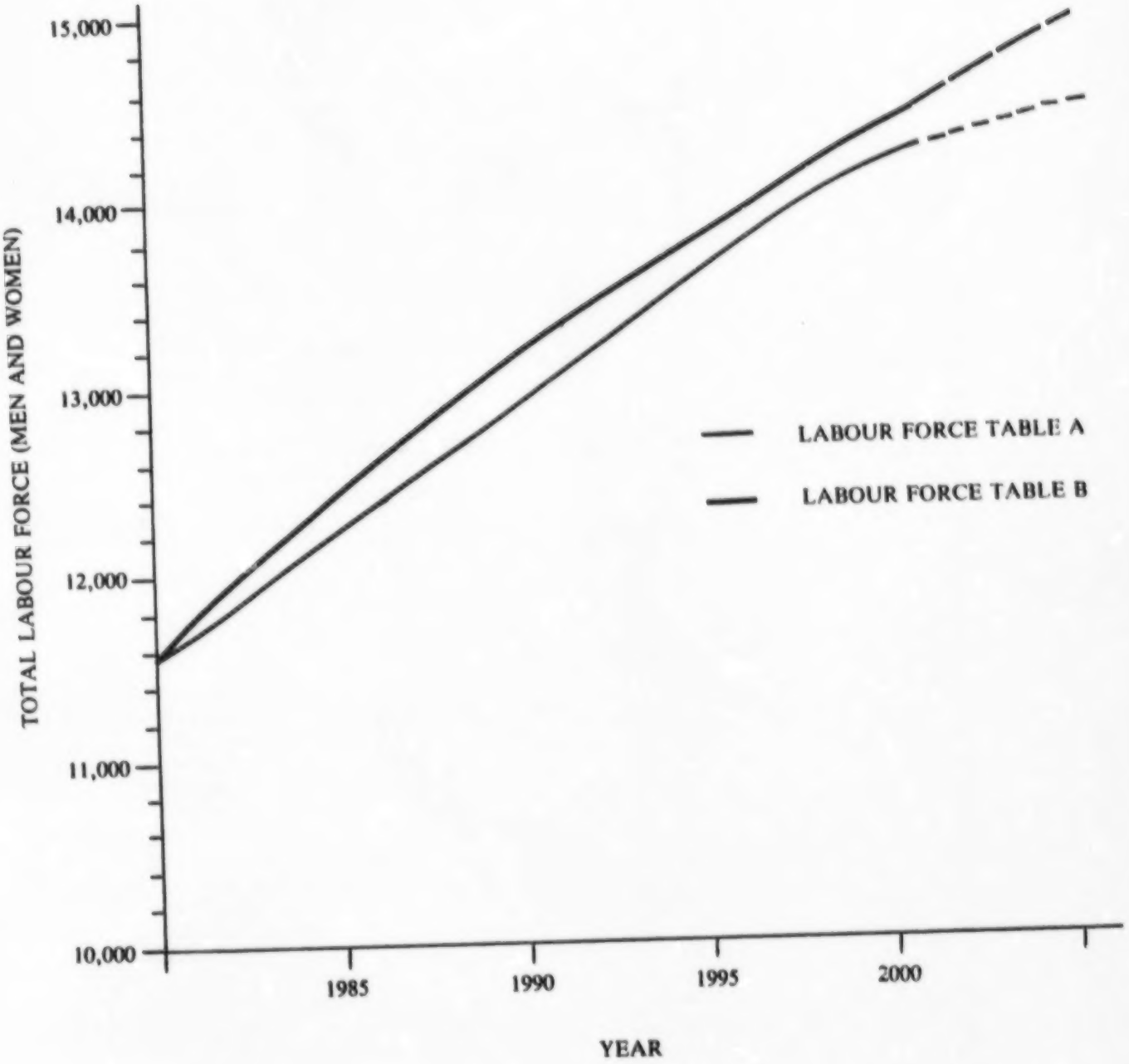
TABLE A3
LABOUR FORCE FORECAST B

(Assuming declining fertility, low immigration and a continuing increase in the female participation rate).

	15-19	20-24	25-34	35-44	45-54	55-64	65 +	TOTAL LABOUR FORCE	
1980									
MEN	637	999	1920	1404	1143	756	140		11,523
WOMEN	534	815	1228	874	651	367	55		
1985									
MEN	572	981	2064	1638	1194	776	137		12,440
WOMEN	478	826	1442	1133	737	407	55		
1990									
MEN	532	926	2081	1822	1319	796	128		13,193
WOMEN	444	811	1573	1376	883	449	53		
1995									
MEN	506	879	2016	1925	1462	841	115		13,791
WOMEN	422	803	1643	1565	1054	512	48		
2000									
MEN	482	843	1926	1944	1577	906	101		14,212
WOMEN	402	801	1687	1691	1215	595	42		

Source: Office Automation: Key to the Information Society, by Robert Arnold Russel. The Institute for Research on Public Policy, 1981.

CANADIAN LABOUR FORECASTS



APPENDIX C

B. C. HYDRO
1982 ANNUAL ELECTRIC INDUSTRIAL
CONSUMPTION ANALYSIS SUMMARY

Industry classification	Energy GW.h	Percent of Industrial Energy
INDUSTRIAL		
Agriculture	11.75	.06
Forestry	28.42	.15
Fishing & Trapping	17.39	.09
Mines & Quarries	2,877.01	15.54
Food & Beverage	332.46	1.80
Rubber & Plastics	34.02	.18
Leather	.45	neg
Textile	4.09	.02
Knitting Mills	.09	neg
Wood	1,506.00	8.13
Furniture & Fixtures	8.51	.05
Paper and allied ind.	4,666.63	25.21
Printing & Publishing	47.35	.26
Primary Metals	129.75	.70
Metal Fabricating	138.77	.75
Machinery	47.50	.26
Transportation equipment	57.67	.31
Electrical Products	30.64	.17
Non-metallic Mineral Products	266.08	1.44
Petroleum & Coal	341.69	1.85
Chemical & Chemical Products	1,163.47	6.28
Miscellaneous Mfg.	8.83	.05
General contractors	137.32	.74
Special trade contractors	27.68	.15
Transportation	351.87	1.90
COMMERCIAL		
Storage	174.03	.94
Communication	169.62	.92
Electric Power, Gas & Water Util	205.15	1.11
Wholesale trade	306.37	1.65
Retail trade	979.30	5.29
Finance	125.52	.68
Insurance Carriers	12.51	.07
Real Estate & Insurance Agents	330.09	1.78
Apartment Buildings	162.42	.88
Office Buildings	380.51	2.06
Shopping Centres	95.75	.52
Trailer Parks	8.94	.05
Education	648.50	3.50
Health & Welfare	288.42	1.56
Religious Organizations	32.48	.18
Amusement & Recreation Serv	237.40	1.28
Services to Business & Mgmt	67.74	.37
Personal Services	31.46	.17
Accommodation & Food Services	715.03	3.86 *
Miscellaneous Services	78.60	.42
Public Administartion	419.94	2.27
Unspecified	786.40	4.25
Total	18,512.95	100%

JR69.1

POOR

QUALITY

ORIGINAL